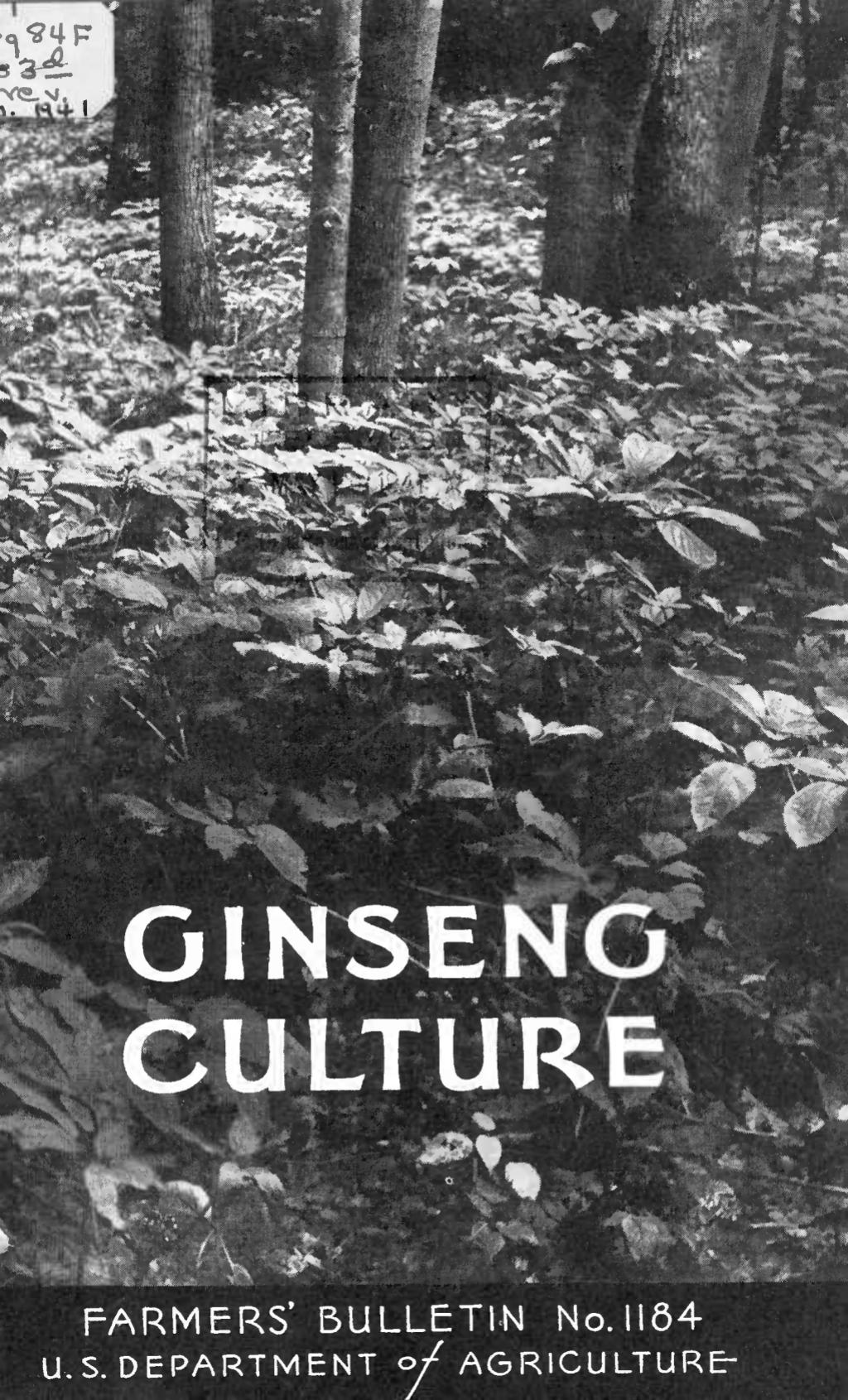


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# GINSENG CULTURE

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U. S. DEPARTMENT of AGRICULTURE

**G**INSENG is a fleshy-rooted herbaceous plant native to this country and formerly of frequent occurrence in shady, well-drained situations in hardwood forests from Maine to Minnesota and southward in the mountain regions to the Carolinas and Georgia.

When placed under cultivation ginseng should be shielded from direct sunlight by the shade of trees or by lath sheds. The soil should be fairly light and well fertilized with woods earth, rotted leaves, or fine raw bonemeal. Seed should be planted in the spring, as early as the soil can be worked. Only cracked or partly germinated seed should be used. Ginseng needs little cultivation, but the beds should at all times be kept free from weeds and grass. A winter mulch over the crowns is usually essential.

The roots do not reach marketable size until about the sixth year from seed. When dug, they should be carefully washed or shaken free from all adhering soil but not scraped. Curing is best effected in a well-ventilated room heated to about 90° F. About a month is required to cure the larger roots.

The average value of the exports of ginseng from the United States for the last 10 years was about \$1,000,000.

Ginseng production is a minor industry which affords an opportunity for profit to only a limited number of judicious growers.

The section on diseases is a condensation of Farmers' Bulletin 736.

# GINSENG CULTURE

By W. W. STOCKBERGER, *principal physiologist in charge, Office of Drug, Poisonous, and Oil Plants, Bureau of Plant Industry*<sup>1</sup>

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## INTRODUCTION

**G**INSENG is a native product of recognized importance. The export trade in dry roots has existed for more than a century and for the last 10 years has attained an average value of about \$1,000,000.

The natural production of ginseng, diminished by overcollection and the contraction of suitable forest areas, has dwindled to such an extent that prices have risen to levels warranting cultivation, which has proved successful in judicious hands. The plant, however, has little domestic value except for the exploitation of amateur cultivators and depends on a distant oriental market (China) for its standing as a commodity. As a commercial product it would appear particularly liable to overproduction, which danger, however, is greatly lessened by the slow development of the plant and the inherent difficulties of its cultivation.

Under the present conditions of production ginseng offers attractive possibilities to patient cultivators who appreciate the limitations of growth and the slow development of woodland plants in general and are willing to make a material outlay with only scanty returns in view for several years to come, but it holds out no inducement for inexperienced growers looking for quick profits from a small investment.

The culture of ginseng and of special crops generally is best begun in an inexpensive and experimental manner, enlarging the equipment only as reasonable success seems assured. "Plunging" in ginseng is likely to prove disastrous as in other forms of business.

Ginseng is adapted best to the Northeastern, North Central, and North Pacific Coast States and can also be grown successfully in the Appalachian Mountain region. Its culture is not recommended for the South, the Great Plains, or the Southwest.

<sup>1</sup> Revised by A. F. SIEVERS, senior biochemist, Division of Drug and Related Plants.

## THE GINSENG PLANT

American ginseng (fig. 1), botanically known as *Panax quinquefolium* L. of the family Araliaceae, is a fleshy rooted herbaceous plant, growing naturally on the slopes of ravines and in other shady but

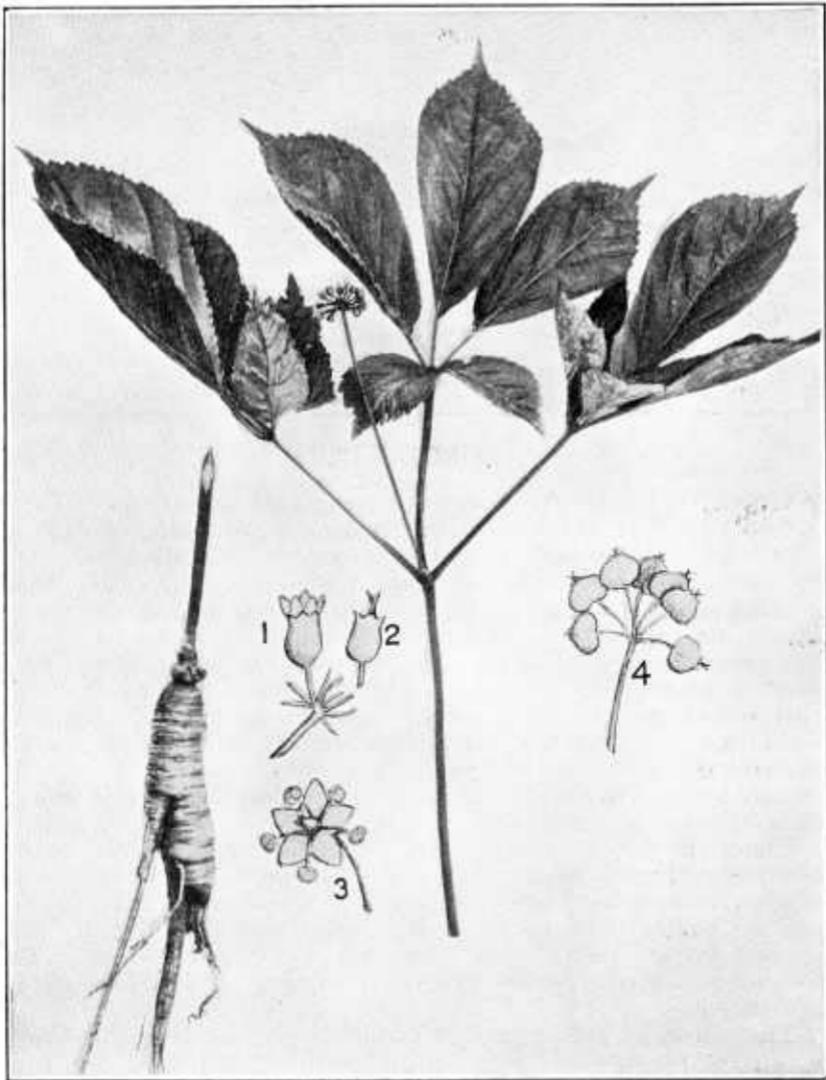


FIGURE 1.—Branch, root, flower and berries of American ginseng.

well-drained situations in hardwood forests, in varying abundance from Maine to Minnesota and southward in the mountain regions to the Carolinas and Georgia. In its wild state it grows from 8 to 20 inches high, bearing 3 or more compound leaves, each consisting of 5 thin, stalked, ovate leaflets, pointed at the apex and rounded

or narrowed at the base, the 3 upper leaflets being larger than the 2 lower ones. A cluster of from 6 to 20 small greenish-yellow flowers is produced in midsummer, followed by as many bright-crimson berries, each containing from 1 to 3 flattish wrinkled seeds the size of small peas. The berries of northern ginseng rarely contain 3 seeds, but in southern ginseng berries containing 3 seeds are very common.

The root is thick, spindle-shaped, 2 to 4 inches long, and  $\frac{1}{2}$  to 1 inch or more in thickness, in the older specimens generally branched and prominently marked with circular wrinkles. Branched roots of the wild Manchurian and Korean ginseng having some resemblance to the human form are said to be in particularly high favor in China, but this feature gives no special value to American ginseng. The seeds (fig. 2) are slow in germination and should never be permitted to become dry. As soon as they are gathered they should be mixed with twice their bulk of moist sand, fine loam, sawdust, or woods earth, and stored in a damp, cool place until they are planted. As a rule the seeds do not germinate until a year from the spring following their ripening, and this fact must be borne in mind in purchasing seed for planting.

Ginseng seedlings grow about 2 inches high the first year, with 3 leaflets at the apex of the stem. The second-year plants may reach a height of 5 or 6 inches, bearing 2 compound leaves, each composed of 5 characteristic leaflets. A third leaf is generally added the next year, when fruits may be expected. In succeeding years a fourth leaf is formed, and the fruiting head reaches its maximum development. A single plant of southern ginseng sometimes produces as many as 300 seeds, but northern ginseng very rarely produces more than 100 seeds to the plant, and under cultivation, the average seldom exceeds 40.

### VARIETIES

There are various recognizable geographical races of American ginseng, not all of which are of the same value to the grower. Plants from the northern range, particularly those indigenous to New York and Wisconsin, appear to possess the most useful characteristics and form the best basis for breeding stocks. Southern ginseng, though vigorous and forming roots of good size and shape, does not seed well at first in northern localities, but after a few years it becomes adapted to the climate and will mature seeds before frost. Some of the western types have long, thin roots of undesir-

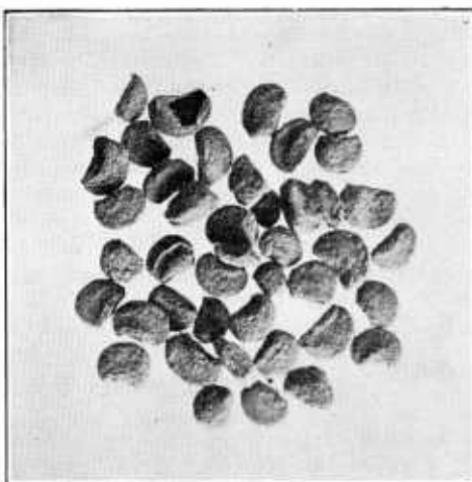


FIGURE 2.—Seeds of American ginseng (natural size).

able character, and another local form, dwarf in growth, has small, round, and almost worthless roots. The beginner should endeavor to procure from reliable dealers the best commercial types of ginseng as a foundation for his breeding stock.

The culture of native ginseng has been too brief to induce varietal changes, but liberal fertilization and continual selection of seeds from individual plants having superior commercial characteristics will doubtless in the end favorably modify the wild type of plants.

## SUITABLE SOILS

Soil and location are very important in the culture of ginseng, as it is a plant that grows naturally on the slopes of ravines and in other well-drained situations where the soil is formed from the acid leafmold of hardwood forests. The soil should be naturally dry, fairly light, and in a condition to grow good vegetables without the addition of strong manure. An absolutely new soil with the best of natural drainage is to be preferred. Very sandy soil should be avoided, as it tends to produce hard, flinty roots of inferior value. Although almost any fairly good soil can be brought into a condition suitable for ginseng by proper treatment, the cost of satisfactory sterilization is usually heavy. In numerous cases the addition of leafmold from hardwoods has given best results, since ginseng requires an acid soil. For seedbeds the soil should be half woods earth free from fiber, and, if it is inclined to be heavy, enough sand should be added so that the mixture will not bake or harden even after heavy rains.

## GROWING THE CROP

Before the diseases of ginseng became such a menace to the industry, practical growers advised the starting of ginseng plantings with both young roots and seeds. By planting roots 3 or more years old a moderate seed crop may be had the first year, and a stock of 1-year or 2-year roots set at the same time will start the rotation which is necessary to provide for a marketable crop of roots each year after the first crop is harvested. However, the grower who purchases roots for planting incurs the risk of introducing diseases into his bed, and it appears to be the better policy not to take chances with roots but to depend entirely upon seeds.

Ginseng seeds are advertised for sale by many of the older growers and are usually procurable at prices varying from 50 cents to \$1.50 per thousand. Seeds are often sold by weight, and it is estimated that 1 pound of average northern seed should produce 7,000 to 8,000 plants, and 1 pound of average southern seed 10,000 plants or more. Stratified seeds usually cost more than fresh seeds, but are regarded as far more satisfactory. Dealers almost invariably supply seed that is at least a year old unless new seed is specially requested. As the output of seeds is likely to become greater than is necessary to extend the plantation, it is well to restrict seed production by nipping the flower heads unless a good market for the seeds is assured. Roots gain more rapidly in size and weight if the plants are not permitted to seed.

## PLANTING

Except in the far Northwest it is best to plant ginseng seeds in the fall. If they are held until spring, growth may start before they can be planted, in which case many may be lost. Only cracked or germinated seeds should be used. They should be planted 8 inches apart each way in the permanent beds, or 2 by 6 inches in seedbeds and the plants transplanted when 2 years old to stand 8 inches apart. The seeds should be covered 1 inch deep with woods soil or old rotten hickory or basswood sawdust; that from pine or oak trees should not be used. The roots may be set in October or later in the fall so long as the soil is in suitable condition, the crowns being placed about 2 inches below the surface. The most approved distance to plant is 8 inches apart each way, when roots are to be grown until 7 years old in permanent locations.

Many planters round the surface of the beds, making the center several inches higher than the sides, since they find space for more plants on the curved than on the flat surface; but others claim that the possible injury from drought in very convex beds more than offsets this advantage. It is important, however, to have the beds well built up with centers high enough not to retain water after a rain. The paths or alleys should be much lower than the beds, and if they decline from one end to the other they will serve as surface drains during heavy rains. For roots the beds should be worked not more than 6 to 8 inches deep if on ordinary soil. Very heavy soils may be worked more deeply if necessary to obtain better drainage. Seedbeds need not be deeply stirred, as it is not advisable to have them settle to any marked extent.

## SHADING

Ginseng grows naturally in rather dense shade, and under cultivation it must be shielded from direct sunlight by some construction that will reduce the light to about one-fourth its normal intensity. When it is planted in open ground this may be accomplished by erecting sheds open on all sides, but covered at the top with lath or boards so spaced as to cut out nearly three-fourths of the sunlight. It is not advisable to use burlap or muslin for shading, as these materials interfere with the free circulation of the air.

There are many methods of constructing shade, but the most common is to set posts firmly in the ground 8 feet apart each way and about 8 feet high above the ground. Scantlings 2 by 4 inches in size are nailed on top of the posts so as to run the long way of the shed. The shade is usually made in sections 4 by 8 feet long, using common 4-foot laths or slats nailed on strips 2 by 2 inches and 8 feet long. The laths should be spaced from one-fourth to one-half inch apart, according to locality, whether in the North or in the South. These sections of shading are laid on top of the 2-by-4 inch runners and so nailed to the posts that the laths run about north and south, thus giving the plants below the benefit of constantly alternating light and shade (fig. 3). Owing to the high cost of lumber, some growers advocate replacing the runners with No. 4 wire, which is run over the tops of the posts and securely fastened thereto.

In the construction of artificial shade it should be borne in mind that free ventilation is very necessary for ginseng. "The higher the

shade the better" is a maxim worth following, as gardens with a free circulation of air are apparently less likely to become diseased.

Seedbeds made under the regulation garden shade are often further protected by a rather low shade to avoid the washing out of the seeds by the drip from the laths. Poultry netting covered with brush, straw, litter, or burlap, made light in spring and denser as the sun gains power, answers very well. In seedbeds made in the open and protected by a low shade alone the seedlings are very apt to damp-off in warm wet weather.

The beds for permanent planting under shade should be 4 feet wide and preferably should run east and west, being so placed that



FIGURE 3.—Lath shed affording partial shade, well suited for growing ginseng, goldenseal, and other woodland plants.

the drip will fall to a great extent in the paths. The sides may be of 12-inch boards set 8 inches or more in the ground to keep out moles and held in place with small stakes.

#### FERTILIZING

Several weighty arguments may be offered against the excessive use of fertilizers. Heavy feeding tends to lessen the resemblance of the cultivated root to the wild product and consequently reduces its value, as the root most closely resembling the wild in appearance and texture is now in strongest demand. Overfeeding also forces growth and thereby renders the plant less resistant to the attacks of disease. Lime and wood ashes have been used by many growers on their ginseng beds, but either root rust or fiber rot has almost invariably followed their use. If lime is used at all it is well to apply it at least a year before planting. Serious leaf injury has

followed the excessive use of nitrogenous fertilizers, and heavy applications of barnyard manure have also caused severe injury. Experienced growers are now recommending a good rich soil to start with and very moderate forcing.

The very best fertilizers are woods soil or rotted leaves 4 to 6 inches deep, well spaded in to a depth of about 8 inches, and fine raw bonemeal well worked in, applied at the rate of 1 pound to each square yard. If barnyard manures are used they should be very thoroughly rotted, and in order to give the best results they should be worked in some months previous to planting the beds. Some practical growers advise against the use of animal manures or even a soil to which they have been heavily applied. Chemical fertilizers and wood ashes have been used, but as very injurious results have sometimes followed, it is best, for the beginner at least, to depend on hardwood leafmold, old rotted hardwood sawdust, and raw ground bone to enrich the soil.

### CULTIVATING

Ginseng requires little if any cultivation, but grass and weeds should be kept out of the beds, and the surface of the soil should be scratched with a light tool whenever it shows signs of caking. Ordinarily one active man can easily care for about 2 acres of ginseng.

### MULCHING

In accordance with natural conditions, a winter mulch over the crowns is essential, especially in northern localities. Seedling beds particularly require careful mulching to prevent heaving by frost.

Forest leaves held in place with poultry netting, light brush, or sawdust are best, but cornstalks stripped of the husks, bean vines, cowpea hay, buckwheat straw, or other coarse litter not containing weed seeds or material attractive to mice will answer the purpose. The mulch should not be placed in position until actual freezing weather is imminent, and it should be removed in the spring before the first shoots come through the soil.

A mulch of 4 or 5 inches of leaves or their equivalent in litter is ample for the severest climate, and less is needed in the South. A light summer mulch of sawdust helps keep down weeds and prevents excessive loss of moisture in dry weather.

### DRAINAGE

In laying out ginseng beds provision must be made for efficient drainage. The preferable location is on ground that has a gentle slope, but as natural drainage cannot be depended on always to remove excess water from beds, some type of underground drain must be employed. Very satisfactory results have been obtained by the use of clay or cement drain tile in ginseng beds. A line of tiles should be placed under the center of each bed. The proper depth of the drain will vary with the character of the soil, and the size of the tiles will depend on the amount of rainfall. In general, if 3-inch tiles are used the drains should be placed 6 to 8 feet apart and 1½ to 2 feet deep in clay and 3 to 4 feet deep in sand or gravel.

### FOREST PLANTINGS

The earlier successes with ginseng culture were made with plantings in hardwood forests, and this method is still preferred by many growers when a suitable location is available. However, the yield from forest plantings is said to be about one-half that obtained under artificial shade, but on the other hand there is a large saving in the expense for labor and the cost of shading. Growers on the Pacific coast have found that ginseng cannot be grown successfully under tree shade in that region.

In forest plantings the beds should be placed where the shade is continuous and fairly dense. The shade should be produced by tall, open-headed, hardwood trees rather than by undergrowth, to insure free circulation of air. Some experienced growers prefer to plant on land that slopes to the north, thereby providing good drainage, without which ginseng will not thrive, and the coolest location during the heat of the summer. The soil should be deeply plowed or spaded and all tree roots removed. The growth of these roots into the beds should be prevented by occasionally cutting around them with a sharp spade. A liberal quantity of leafmold or well-decayed litter should be worked into the soil, and an application of bonemeal raked into the surface will in most cases be a desirable addition. Ginseng may be planted closer under forest conditions than in garden culture, but in either case the closer the plants stand the greater is the danger from disease. The culture of forest beds is in all respects similar to that of beds under artificial shade, and the winter mulch should in no case be omitted.

### PROTECTION

Owing to the comparatively high cost of ginseng plants and roots, the beds should be well protected by fences from the intrusion of wild or domestic animals and should also be carefully guarded against theft, which is not uncommon with this high-priced product. Protection is especially needed with forest plantings, which should always be well enclosed. Moles may be controlled with suitable traps,<sup>2</sup> of which several kinds are on the market. Mice often cause great damage to ginseng, but they may be kept from the beds by wire netting of sufficiently close mesh set 12 to 18 inches in the ground.

### DIGGING AND DRYING THE ROOT

The cured root is valued by the Chinese largely according to its size and maturity. The best qualities at proper age break with a somewhat soft and waxy fracture. Young roots dry hard and glassy and are regarded as less desirable. Very small young roots and root fibers often realize less than a dollar a pound, whereas those of the proper size and quality sell readily at top quotations. Undersized or stunted roots if of suitable age are readily salable. Cultivated roots as a rule attain greater size than wild ones of the same age, but on account of their more rapid growth they are harder and denser than the wild roots, and if harvested before they are about 5 years old they will lack in flavor and quality.

Beds should rarely be dug for market until about the sixth year and should then be taken up solidly. The replanting of the under-

<sup>2</sup> See U. S. Department of Agriculture Farmers' Bulletin 1716, Mole Control.

sized or stunted roots is of doubtful value, since they frequently make little more growth. Good roots should run nearly 4 inches long and half an inch in thickness below the crown and should average about an ounce in weight in the fresh state.

Roots may be dug at any time after growth ceases in September, but mid-October is regarded as the most favorable time. They should be carefully washed or shaken free of all adhering soil, but not scraped or scrubbed, as it is important to preserve the natural dusky color of the skin with its characteristic annular markings.

The older roots possess the most substance and when properly cured realize the highest prices. In recent years a demand for ground ginseng has established a market for young roots, which are preferred for milling on account of their hard, flinty texture.

Drying is best effected in a well-ventilated room heated by a stove or a furnace. It has long been customary to start drying between 60° and 80° F. and after a few days to increase the temperature to about 90°, but some experienced growers now recommend that drying start between 100° and 110° and as soon as the roots are wilted that the temperature be reduced to about 90°.

The roots are spread thinly on lattice trays or shelves made of wire netting and are frequently examined and turned, but must always be handled carefully to avoid breaking the forks or marring the surface. Roots measuring more than 2 inches in diameter will need to be dried for about 6 weeks, but smaller roots may be properly dried in less time. In all stages of curing, especially in noticeably damp weather, particular care should be taken to see that the root does not mold or sour, as any defect will greatly depress the selling price. On the other hand, overheating should be avoided, as it tends to discolor the surface and spoil the texture of the interior. Once well cured, the roots should be stored in a dry and airy place, secure from vermin, until ready for sale.

### DISEASES<sup>3</sup>

Cultivated ginseng is frequently subject to severe attacks of a number of diseases, the development of which appears to be especially favored by crowding of the plants, excess water in the soil, and lack of proper ventilation.

In their natural state the plants as a rule are thinly scattered on the forest floor under advantageous conditions of ventilation and soil drainage, the normal action of tree roots playing no inconsiderable part in the latter condition, and diseases are likely to remain local in effect. Under the crowded conditions of commercial culture, however, the diseases tend to spread and may cause material injury. Errors in fertilization and soil treatment are also frequent causes of injury and by weakening the resistance of the plants may further invite the inroads of disease.

### ALTERNARIA BLIGHT AND ROOT ROT<sup>4</sup>

Alternaria blight is one of the most widespread ginseng diseases and affects both leaves and roots. During the spring the stems of diseased

<sup>3</sup> Condensation of Farmers' Bulletin 736, Ginseng Diseases and Their Control, prepared by S. P. Doolittle, senior pathologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.

<sup>4</sup> *Alternaria panax* Whetzel.

plants show dark-brown cankers just above the ground line, which enlarge and become covered with a velvety brown coating of the spores (microscopic seedlike bodies) of the fungus causing the disease. Later in the season, large, watersoaked spots develop on the leaves and eventually become papery and dry with a darker, yellow-brown margin (fig. 4).

Later the leaflets may droop where the leafstalk rises at the top of the stem, and brown spore masses may form again at this point. Seed heads are affected, and when such infection occurs the berries often shell. When roots are attacked they rot very slowly, and there is no odor. The lesions are dark brown or black, and the rotted roots

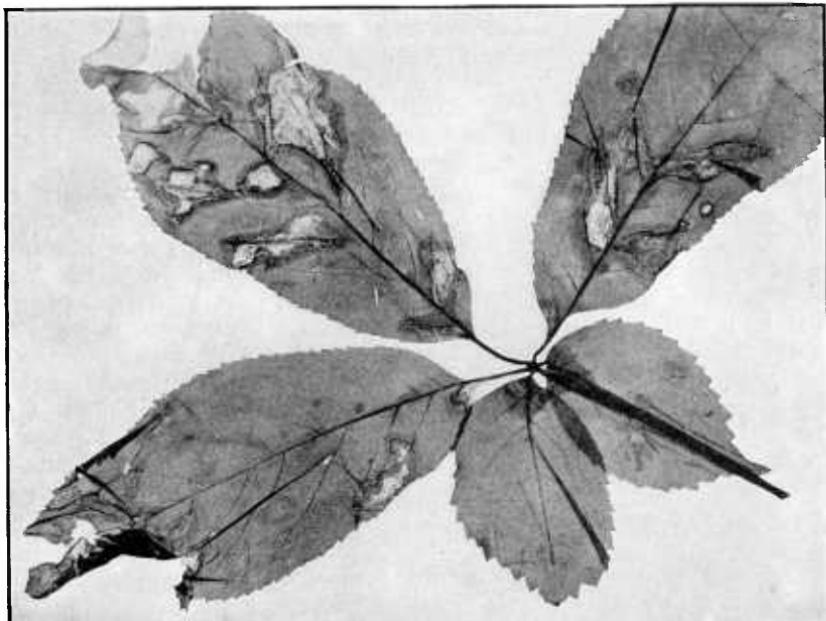


FIGURE 4.—Leaves of ginseng affected with alternaria blight.

remain firm. Root infection apparently occurs only in roots that have been injured.

The spores of the fungus are distributed by the wind and may be carried on clothing from diseased to healthy beds. During moist weather the spores that have lodged on the plants germinate and produce further infection. Because the fungus also lives over winter on diseased leaves and stems of the previous season, it is important that diseased tops be removed and destroyed. After the tops die down the beds also should be disinfected by being soaked down to a depth of an inch with a solution of 1 pound of copper sulfate to 7 gallons of water. The most effective means of control, however, consists in spraying the plants during the growing season with a 3-3-50 bordeaux mixture to which 2 pounds of calcium arsenate have been added (fig. 5). The first application should be made when the

majority of the plants have broken through the soil, the second when the leaflets are fully spread, the third just before blossoming, and the fourth after the fruits are set.

Bordeaux mixture can be purchased in paste and powder form and such preparations are often convenient for use in small plantings. It is somewhat more effective when freshly prepared, however, and can be made more cheaply at home by the following formula: Dissolve 3 pounds of copper sulfate in hot water, using a wooden or earthenware vessel, and dilute to 25 gallons with water. Slake 3 pounds of stone lime (or 5 pounds of hydrated lime) in a small amount of water and dilute to 25 gallons. Pour the two solutions together while stirring and add 2 pounds of calcium arsenate. When only small quantities of the spray are needed, it may be prepared by using 3 ounces of copper



FIGURE 5.—Sprayed and unsprayed ginseng plants attacked by alternaria blight. Except that one was sprayed, both beds received the same treatment.

sulfate and 3 ounces of stone lime or 5 ounces of hydrated lime to a total of 3 gallons of water and adding 2 ounces of calcium arsenate.

#### PHYTOPHTHORA MILDEW AND ROOT ROT <sup>5</sup>

Phytophthora mildew and soft rot is a fungus disease that affects leaves, stems, and roots of plants of all ages and frequently is very destructive. The leaflets at the top of the diseased plants often droop at the base of the petiole in much the same manner as in alternaria blight and the stems become hollow and discolored. The leaf blades also show spots that in their earlier stages resemble those of alternaria but, although the centers become white, the margins remain a dark, water-soaked green and do not show the yellow-brown border characteristic of alternaria spots (fig. 6). Infected roots develop a soft rot and eventually are invaded by other fungi and bacteria which produce a disagreeable odor.

<sup>5</sup> *Phytophthora cactorum* (Cohn. and Leb.) Schröter

This fungus overwinters in the tissues of diseased plants in the soil and spring infection occurs either in roots or stem, but in either case both roots and tops eventually may become diseased.

The most effective control for the disease consists in spraying with bordeaux mixture as for alternaria blight. To prevent the fungus from passing down the stem to the roots, all wilting or drooping tops should be cut off at the crown and removed. Affected roots should

also be removed and destroyed, and the bed disinfected with a solution of 1 pound of copper sulfate in 7 gallons of water. Beds that are infested with this fungus should not be used for a number of years, but if for any reason infested beds must be used, they should be sterilized with steam<sup>6</sup> or with a solution of 1 part of formaldehyde to 50 gallons of water. In using formaldehyde, all roots are first removed and the ground loosely spaded. The solution is then applied at the rate of  $\frac{1}{2}$  to 1 gallon per square foot in sufficient quantity to thoroughly saturate the soil. As soon as it can be worked, the soil should then be spaded over to allow the formaldehyde to evaporate. This stirring of the soil should be repeated at intervals for at least 2 weeks before any planting is done, as formaldehyde fumes are injurious to growing plants.



FIGURE 6.—Leaf-spot of *phytophthora* mildew on ginseng.

due to a fungus that penetrates the water-conducting vessels of the root and causes a gradual wilting of the top. Diseased roots seem healthy externally, but when cut across show a yellow zone in the conducting tissue. Diseased roots should be dug and dried to remove the source of infection, and beds where the disease has occurred should be disinfected with formaldehyde or steam.

#### RAMULARIA ROOT ROT<sup>8</sup>

Ramularia root rot or "rust" is due to a fungus that may attack the roots of plants of all ages but is commonest on seedlings, which often

#### ACROSTALAGMUS WILT<sup>7</sup>

Acrostalagmus wilt is a disease of older plants and rarely causes severe damage. It is

<sup>6</sup> See Farmers' Bulletin 1629, Steam Sterilization of Soil for Tobacco and Other Crops.

<sup>7</sup> *Acrostalagmus* sp.

<sup>8</sup> *Ramularia* sp.

are rendered worthless. On older roots the spots are a rusty brown but do not penetrate deeply. In seedlings the fine rootlets are damaged and the taproot may become short and knoblike. The disease is favored by an alkaline soil and where it occurs the use of lime or wood ashes should be avoided.

### SCLEROTINIA ROTS

There are two ginseng diseases caused by fungi of the genus *Sclerotinia*. One, sclerotinia white rot,<sup>9</sup> occurs in most sections where ginseng is grown but rarely causes widespread damage. It also affects many vegetable crops, and this probably explains its presence in beds on soil where such crops have previously been grown. The disease affects the roots and stem but does not spot the foliage. The diseased stems lose their green color and become hollow. Infected roots rot rapidly, and the tissues are soft and brittle but without bad odor. Within the stem and on the outside of the root, hard, black bodies are formed, sometimes one-quarter of an inch long, which are known as sclerotia. These are the resting bodies of the fungus and remain in the soil over winter. In the spring they produce small cuplike bodies containing spores, which serve as sources of new infection. Good drainage and aeration will do much to prevent losses from the disease. Infected plants should be removed and burned and the soil from which they came disinfected with a copper sulfate solution as described for phytophthora mildew (p. 12).

The other disease of this group, sclerotinia black rot,<sup>10</sup> probably occurs on wild ginseng and also affects the plant known as false solomonseal.<sup>11</sup> It is probably often introduced through forest soil used in making up ginseng beds. It attacks only the roots, making little progress during the growing season. Its presence is indicated by failure of certain plants to come up in the spring, and on digging only black, mummylike roots will be found. Sclerotia are formed on these roots as in the case of white rot, and all roots in the diseased area should be removed and the soil disinfected as previously described (p. 12).

### DAMPING-OFF OF SEEDLINGS

Damping-off of seedlings is characterized by a decay of the stem at the surface of the soil, which results in a falling over and death of the affected plants. The disease may be caused by a number of fungi which are commonly present in the soil and whose attacks are favored by excessive moisture and lack of aeration. Good drainage is therefore essential in raising seedlings. Sprinkling sand on the surface of the bed to a depth of one-eighth to one-fourth of an inch is also sometimes of value in checking damping-off. When planted in drills the soil should be kept stirred, particularly after rains. If seedbeds can be sterilized with formaldehyde (p. 12) before planting, losses from damping-off usually can be greatly reduced. Red oxide of copper has recently been widely used to control damping-off of vegetable seedlings. It is applied as a dust and the seed is shaken in a closed container with sufficient dust to thoroughly coat the seed. The excess dust is then screened off and the seed planted. The information available, how-

<sup>9</sup> *Sclerotinia sclerotiorum* (Lib.) Massee.

<sup>10</sup> *Sclerotinia smilacina* Dur. = *S. panacis* Rankin.

<sup>11</sup> *Smilacina racemosa* (L.) Desf.

ever, does not warrant a statement as to its effect on ginseng seed and, if it is used, a small sample of seed should first be dusted and tested to determine whether the treatment affects seed germination.

#### ROOT KNOT<sup>12</sup>

Root knot, a serious disease affecting nearly 1,500 different plants, is found on ginseng roots in many regions. It is caused by a nematode or eelworm,<sup>13</sup> that lives in galls on the underground parts of the plants (fig. 7). Galls start as very slight swellings but may reach a diameter of one-half inch or more. By careful examination the shiny, white,

pear-shaped female nematodes, usually much smaller than a pinhead, can be found in the galls with the unaided eye. This disease destroys ginseng seedlings; it reduces the market value of mature roots, and also makes them unfit for propagation.

The eradication of root knot from the soil is very difficult. It is best accomplished by running steam<sup>14</sup> through lines of 3- or 4-inch tiles buried 18 to 22 inches apart and 15 to 18 inches deep or through perforated pipes laid temporarily. If drainage is required in the ginseng bed an adaptation of the tiles for double service should be considered. A temperature of 135° F. should be maintained throughout the soil quantities of boiling



FIGURE 7.—Ginseng roots showing nematode galls.

for half an hour. Drenching it with large water is a possible alternative, provided that the soil deeper than any roots have grown is heated to the above temperature. Pan steaming, formerly recommended, does not kill nematodes to a sufficient depth. No chemical treatment of soil has yet proved 100-percent effective.

To avoid losses from this disease, it is essential to start ginseng plantings in nematode-free land, using absolutely healthy roots or seed that has not been in contact with infested soil. Drainage water from

<sup>12</sup> Revision of this section prepared by Jocelyn Tyler, junior nematologist, Division of Nematology, Bureau of Plant Industry.

<sup>13</sup> *Heterodera marionii* (Cornu) Goodey.

<sup>14</sup> See footnote 6.

an infested area must not flow onto the new beds. Implements must be cleaned and thoroughly dried so as not to introduce any contaminated soil. Fertilizers and mulching materials must come from nematode-free sources.

### YIELD AND VALUE OF THE CROP

The yield of cultivated ginseng varies greatly and depends largely on the suitability of the conditions under which the crop is grown and on the skill and experience of the grower. It has been estimated that the roots from a bed measuring 4 by 16 feet, if dug when 6 years old, should weigh about 10 pounds when dry. Yields of dry root from well-managed plantings appear to be at the rate of a ton to the acre, although much larger yields are frequently reported.

Ginseng has long been valued by the Chinese for medicinal use, though rarely credited with curative virtues by other peoples. The dried roots have been exported from the United States in increasing quantities since the early years of the eighteenth century, the prices rising as the wild supply diminished from about 40 cents a pound in the early years of its collection to \$24 a pound for the best qualities during 1927. Since then the price has declined greatly.

The cultivation of native ginseng, stimulated by its increasing scarcity and the rising prices, began in an experimental way about 1886, and for a time developed slowly. It is estimated that in 1901 a little less than 20 acres of ginseng were under cultivation in the United States, and, of the root produced, but a small quantity went into the market. In recent years the industry has attained such proportions that the output of cultivated roots appears to be considerably greater than that collected from the forests.

When cultivated ginseng first appeared on the market it sold at prices considerably higher than those paid for the wild root, but about 1904 the price declined to a figure less than that commanded by wild ginseng, and since that time it has for the most part remained at a lower level. The preference in the Chinese markets for wild ginseng over the American cultivated root appears responsible for the difference in the prices offered for wild and cultivated ginseng in the markets of the United States.

A negligible quantity of ginseng is consumed by Chinese residents of North America, and a trifle has been used by manufacturers of domestic medicine, leaving practically the sole outlet for ginseng with the Koreans and Asiatic Chinese. The domestic prices, exports, and valuation of American ginseng from 1914 to 1938, inclusive, are shown in table 1.

### THE OUTLOOK FOR THE INDUSTRY

The future success of cultivated ginseng in North America will be determined to a great extent by the attitude of the growers. If the lessons taught by the experience of the preceding 25 years are heeded, the mistakes of the past need not be repeated, and many obstacles that have heretofore hampered the progress of the industry can be removed.

TABLE 1.—*Domestic prices, exports, and value of American ginseng from 1914 to 1938, inclusive*

Year	Domestic prices (per pound) <sup>1</sup>				Exports <sup>2</sup>		
	Wild root		Cultivated root		Quantity	Total value	Average value per pound
	High	Low	High	Low			
1914	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Pounds</i>	<i>Dollars</i>	<i>Dollars</i>
1914	11.50	6.00	8.00	3.00	224,605	1,832,686	8.15
1915	9.50	4.50	7.00	2.00	103,184	919,931	8.91
1916	11.00	5.00	6.50	3.00	256,082	1,597,508	6.23
1917	14.00	6.00	7.00	2.50	198,480	1,386,203	6.98
1918	19.00	9.50	9.00	3.00	259,892	1,717,548	6.60
1919	23.00	13.00	12.50	3.00	282,043	2,057,260	7.29
1920	23.00	10.00	12.00	3.00	160,050	1,875,348	11.71
1921	12.00	6.50	8.00	1.00	181,758	1,507,077	8.29
1922	16.00	7.00	12.00	2.00	202,722	2,334,993	11.51
1923	18.00	12.00	15.00	3.00	148,385	2,245,258	15.13
1924	16.50	11.00	14.00	2.00	167,318	2,399,926	14.35
1925	15.00	7.50	13.00	2.00	138,131	1,668,221	12.07
1926	19.00	10.00	13.00	3.00	180,262	2,640,488	14.65
1927	24.00	12.50	13.00	4.00	169,000	2,556,000	15.12
1928	20.00	10.00	12.00	3.50	184,000	2,288,000	12.43
1929	18.50	10.00	12.00	2.00	234,000	2,766,000	11.82
1930	15.50	6.00	11.00	2.00	203,000	1,877,000	9.24
1931	12.00	5.00	9.00	2.00	265,000	1,922,000	7.25
1932	10.00	5.00	7.00	.75	171,000	835,000	4.88
1933	7.00	4.00	4.00	.50	233,000	844,000	3.62
1934	12.50	6.00	3.00	.25	232,000	1,203,000	5.23
1935	7.00	6.00	4.00	2.00	167,000	618,000	3.70
1936	7.00	6.00	4.00	2.00	295,000	1,236,000	4.19
1937	7.00	6.00	11.00	2.00	136,000	706,000	5.18
1938	7.00	6.00	11.00	10.00	167,000	1,028,000	6.15

<sup>1</sup> Prices for 1914 to 1931 were compiled from Hunter-Trader-Trapper, prices for 1932 to 1934 from Special Crops, and those from 1935 to 1938 from Oil, Paint and Drug Reporter.

<sup>2</sup> From annual reports of Foreign Commerce and Navigation of the United States.

The industry still suffers from the disrepute into which it was brought through exaggerated claims made by some dealers in seeds and nursery stock with regard to the possibilities for unusually large profits in the growing of ginseng. Although ginseng is a comparatively unimportant product in this country, it has a place among minor crops of recognized value. For every dollar's worth of ginseng exported in 1938 there were produced in this country about \$45 worth of peanuts, \$15 worth of onions, \$30 worth of strawberries, \$3 worth of asparagus, and \$5 worth of cranberries.

In comparison with that of other crops, the market for ginseng is small; consequently the industry affords an opportunity for only a limited number of persons without danger of becoming overcrowded. Because yields of the dry root from well-managed plantings appear to be at the rate of a ton to the acre, only a little more than 100 acres of mature ginseng could very readily supply 210,000 pounds of roots, which is the average exportation for the last 10 years. This would represent total plantings of nearly 600 acres, as it requires at least 6 years to grow marketable roots from seed.

The Chinese market formerly absorbed ginseng in quantities considerably in excess of the average exportations for the two decades just past. As shown in table 2, the number of pounds exported during the last 10 years is less than half of the exports for the 10 years 1860-69, and the average price per pound for the 10 years 1929-38 is nearly seven times as great as it was some 70 years ago.

TABLE 2.—*Exports and value of American ginseng for the periods indicated, from 1860 to 1938, inclusive*

Period	Quantity	Value	Average value per pound	Period	Quantity	Value	Average value per pound
1860-69-----	4,149,445	\$3,902,209	\$0.94	1900-1909-----	1,513,558	\$9,610,614	\$6.34
1870-79-----	4,041,727	4,537,008	1.12	1910-19-----	2,047,800	14,823,781	7.24
1880-89-----	3,457,294	6,771,830	1.95	1920-29-----	1,764,800	22,280,000	12.63
1890-99-----	2,163,302	7,843,888	3.62	1930-38-----	1,869,000	9,634,000	5.15

As shown in table 1, the annual exports of ginseng root vary considerably from year to year without any pronounced trend with respect to quantity, but the market value of the root has declined more or less steadily since 1927, when it was \$15 a pound. This decline may be due to two causes, overproduction and a change in the proportion of cultivated and wild roots in the supply available for export. About 10 years ago there was quite an increase in the number of ginseng gardens, although accurate statistics indicating the change in the total acreage under cultivation and the number of growers in the last decade are not available. It is believed, however, that some overproduction may have occurred. The supply of wild ginseng is declining yearly, and, since the wild root is generally of higher market value than that from cultivated plants, a smaller proportion of the former in the exports would reduce the average value per pound.

The evident preference of the Chinese for the wild root and the unsatisfactory state of the general market for cultivated ginseng have caused grave doubts as to the future prospects of the industry. These doubts will probably be realized unless growers give more attention to the production of the type of root desired by the Chinese trade. In the future, growers should strive for quality of product and not for quantity of production, as has been the all too common practice in the past. There is always a ready sale for the cultivated roots which closely resemble the wild in quality and conditions, and prudent growers will not fail to adopt the wild root as the standard of future production. The elimination of the poorer grades of cultivated American ginseng, which are now found in the markets, would tend to insure more uniform prices for the root and to lessen the danger of depressing the market through overproduction.

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